PORTRAIT OF YOUR STREAM: DEVELOPMENT AND ASSESSMENT OF A STREAM ECOLOGY PROGRAM FOR MIDDLE-SCHOOL STUDENTS

Brenda J. Swirczynski, B.S.

Thesis Prepared for the Degree of

MASTER OF SCIENCE

UNIVERSITY OF NORTH TEXAS

May 2001

APPROVED:

James H. Kennedy, Major Professor
Charlotte Bryant, Committee Member
Betty Crocker, Committee Member
Earl G. Zimmerman, chair of the Department of Biological Sciences
C. Neal Tate, Dean of the Robert B. Toulouse School of Graduate Studies

Swirczynski, Brenda J., Portrait of your stream: Development and assessment of a stream ecology program for middle-school students. Master of Science (Environmental Science), May 2001. Essay, 66 pp., 10 tables, 2 illustrations, references, 22 titles. Curriculum, 174 pp.

Portrait of Your Stream (POYS) is a stream ecology and student action program designed for use with middle-school students. The program is correlated with learning cycle pedagogical methods emphasizing student-centered lessons and activities in both classroom and outdoor settings. Implementation of a pilot program in the Fall semester of 1999 was used to collect formal and informal responses and data from students and teachers. Data included changes in student knowledge, skills and attitudes and were analyzed for determination of the success of program objectives and modifications to the program. The final POYS program is currently distributed and administered by the Botanical Research Institute of Texas.

ACKNOWLEDGEMENTS

The author would like to thank the education staff of the Botanical Research Institute of Texas for their support and to the teachers and students of Stripling Middle School in Fort Worth, Texas for their participation and involvement.

TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF ILLUSTRATIONS

Figure

CHAPTER 1

Overview of Environmental Education

Environmental education has become an important link to understanding the often complex relationship humans have with their surroundings. In 1978, the world=s first intergovernmental conference on environmental education was organized by the United Nations Education, Scientific, and Cultural Organization and was convened in Tbilisi, Georgia (USSR). The Tbilisi Declaration, a result of this conference, has helped environmental educators define the basic scope and purpose of environmental education ever since (Davis, 2000). Three broad objectives for environmental education were endorsed as a result of this conference and outlined in the Tbilisi Declaration:

1. To foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;
2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment;
3. To create new patterns of behavior of individuals, groups, and society as a whole towards the environment. (UNESCO, 1978)

Along with these objectives, five general categories of environmental education were also outlined:

1. Awareness: to help individuals acquire an awareness and sensitivity to the total environment and its allied problems.

2. Knowledge: to help individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its associated problems.

3. Attitudes: to help individuals acquire a set of values and feelings of concern for the environment and the motivation for actively participating in environmental improvement and protection.

4. Skills: to help individuals acquire the skills for identifying and solving environmental problems.

5. Participation: to provide individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems (UNESCO, 1978).

These general objectives and categories served as an important initial catalyst urging educators to identify, organize, and provide valuable and essential knowledge to students and the public. It soon became apparent that in order to meet these goals, educators of environmental education would need to provide the materials and opportunities to their audiences so that the current and future citizens of the world would achieve scientific and environmental literacy.

Scientific and Environmental Literacy

The aim of modern science education is to provide students with experiences that will help them become scientifically literate by understanding and developing scientific attitudes, process skills and knowledge (Martin et al., 1997). Scientific literacy enables students to confront environmental issues and questions in their lives that require scientific information and helps develop ways of thinking to insure the ability to make informed decisions (National Academy of Sciences, 1999). This collective judgment will determine how we manage the future use of shared resources such as water, an increasingly important resource in Texas.

To this end, the broad goals for environmental education are to provide authentic and relevant learning opportunities that allow students to experience the richness and excitement of knowing about and understanding the natural world. Specifically, students should learn to use appropriate process skills and environmental principles when making personal decisions regarding the environment and to demonstrate a capacity for intelligent public discourse and debate about matters of scientific and technological concerns (National Academy of Science, 1999).

While definitions and discussions of what constitutes scientific literacy are plentiful, the idea of environmental literacy is relatively new. Environmental education programs, standards and goals are often developed to include components of strong scientific literacy in addition to general environmental awareness and social action. Defining environmental literacy with an application for environmental education requires fine-tuning and specific consideration must be given to the wide array of topics found in this area. Most types of literacies incorporate cognitive terms in their definitions. While knowledge is certainly an important part of environmental literacy, behavior, action and awareness must also be considered.

When defining any type of literacy, levels of capability are observed but not often defined. The following three levels of knowledge have been offered with respect to environmental literacy:

1. Nominal: Indicating an ability to recognize many of the basic terms associated with the environment and able to provide rough definitions of their meanings.

2. Functional: Indicating a wider knowledge and understanding of the interactions between natural and human social systems.

3. Operational: Indicating understanding beyond functional literacy in both understanding and skills. (Disinger and Roth, 1992)

A primary goal of quality environmental educators should include assessment of the level of students= knowledge. Environmental education programs should then enhance or refine their level of involvement, knowledge and awareness with an ultimate goal of attaining operational levels in the students. Persons at the operational level of environmental literacy are identified by characteristics such as routinely evaluating the impacts of actions, gathering and applying related information, and taking action that promote healthy environments (Disinger and Roth, 1992). While no quantitative results, statistics or other data were found characterizing where most individuals fit in to these levels, this outline offers a useful benchmark for qualitative assessment of students' literacy before and after taking part in an environmental program.

National and Texas Legislation, Organization Programs and Standards for Environmental Education

The Environmental Education Act of 1970 was one of the earliest attempts to bring the importance of environmental education to the attention of the public. However, it received little support from the U.S. Department of Health, Education, and Welfare where it was housed (Disinger, 1992). The first major legislation to focus on environmental education since then is the National Environmental Education Act of 1990 (Public Law 101-619). Unlike its predecessor in 1970, this act names the Environmental Protection Agency (EPA) as the organization responsible for federal environmental education initiatives. The result has been the creation of an office of environmental education within EPA and the operation of a number of programs and projects that have helped to promote environmental education awareness, and learning.

In 1992, the United Nations held its international Conference on Environment and Development. The conference set out to focus on world-wide environmental issues and resulted in the adoption of Agenda 21, a forty-chapter document creating a program for achieving sustainable development by the 21st century. The focus of Chapter 36, "Promoting Education, Public Awareness and Training," served as a valuable benchmark for national programs to follow (EPA, 1995).

Another major player in the formation of national programs and a leader for environmental education standards is the North American Association for Environmental Education (NAAEE). Founded in 1971, NAAEE's mission includes recognizing the need for a comprehensive body of information about environmental issues and associated programs. They also assist educators through publications such as *Environmental Education Materials: Guidelines for Excellence* and *Excellence in EE-Guidelines for Learning (K-12)* (NAAEE, 1999). These publications, along with others published by NAAEE, focus on resources and standards for quality environmental education materials.

Texas Environmental Education Standards

Environmental education is often viewed by educators as a subset of science education, similar to biology or chemistry. Accordingly, the Texas Education Agency (TEA), responsible for public education in the state, does not have separate standards and guidelines for environmental education. Instead, principles of environmental education are seen throughout the science Texas Knowledge and Skills (TEKS) in the form of biology, earth science, human influences, uses of natural resources, and other related areas of study. Many environmental educators and teachers in the state also use the citizenship and civic action component in social studies TEKS when addressing environmental studies.

Because of geographic and population size, diversity of ecosystems and a close relationship with its natural resources, Texas has been one of the states at the forefront in use of environmental education programs. A recent nationwide study of the use of the environment as a context for learning included programs from two Texas schools. Conducted by the State Education and Environment Roundtable, the results of the study were published in *Closing the Achievement Gap* summarizing the programs of forty public schools from thirteen states using the environment as a focus or theme for learning.

Portrait of Your Stream

In an attempt to address some of the needs, concepts, and standards identified in this paper, I have designed and implemented a program for middle- and high school students titled Portrait of Your Stream (POYS). This program includes sixteen lessons and a Student Action guide, which focuses on local stream ecology using data collection during classroom and field-based lessons. The program was written, implemented and tested with middle-school students over a seven-month pilot period. Because of the numerous aspects and variables associated with a project of this nature, qualitative and process-oriented reviews will be noted with equal emphasis as quantitative data when considering the success of the project. For organizational purposes, a broad project objective is outlined with supporting objectives divided into two parts: 1) Research Program, focusing on the research, development and implementation of Portrait of Your Stream pilot program and 2) POYS Curriculum, focused on content, process and format of lessons, field activities and student action guides. Finally, five hypotheses related to the pilot program student assessments are proposed and tested.

Objectives and Hypotheses:

The overall objective of the Portrait of Your Stream program is to create, implement and assess a quality environmental education program aimed at middle-school students. In order to successfully achieve this goal, the following supporting objectives of this program include:

<u>Research Program:</u>

1. Research existing curriculum, programs and lessons focused on stream water quality, stream physical and biotic characteristics, and stream bank restoration.
2. Adapt existing relevant activities and design original lessons for the classroom and field sites for middle-school students.

Specific student objectives include (but are not limited to):

- identification and application of aquatic insect adaptations
- identification and classification of urban water pollution and their sources

- collection and analysis of data in order to determine the health of a stream
- design and implementation of a program to address specific stream problems

3. Recruit and train local teachers to participate in pilot testing of curriculum with target students.
4. Assess students= attitude, knowledge and skills.
5. Conduct statistical analysis of student assessment (knowledge, skills and attitude) data.
6. Assess success of program through both formal and informal teacher responses.
7. Determine modifications and further areas for study and development of the program based on student and teacher responses and student data.

<u>Portrait Of Your Stream Curriculum:</u>

1. Facilitate an environmental knowledge, awareness, and the skills needed by middle-school students to develop an appreciation of local and global water resources.

2. Engage students in student centered lessons and investigations to develop and answer questions.

3. Provide opportunities for students to investigate stream ecology through classroom- and field-based lessons allowing students to acquire meaningful and relevant data and answer resulting questions.

4. Use outdoor sites to facilitate student discovery of connections between students= daily lives and their environment.

5. Design and implement lessons and activities that provide information needed to develop skills and knowledge that encourage students= continued inquiry and investigations

6. Develop students= environmental literacy to a point that will allow sound and thoughtful decision-making and responsible environmental stewardship of local streams and watersheds.

7. Design and provide teacher-friendly curriculum and training aligned with state and national standards to classroom teachers.

Hypotheses:

The following hypotheses will be addressed in completing these objectives:

Ho: Student performance on knowledge assessments will not be significantly affected by the program.

Ha: Student performance on knowledge assessments will be significantly affected by the program.

Ho: Student performance on skills assessments will not be significantly affected by the program.

Ha: Student performance on skills assessments will be significantly affected by the program.

Ho: At least 85 percent of participating students will not achieve 70 percent or better on knowledge assessments.

Ha: At least 85 percent of participating students will achieve 70 percent or better on knowledge assessments.

Ho: At least 85 percent of participating students will not achieve 70 percent or better on skills assessments.

Ha: At least 85 percent of participating students will achieve 70 percent or better on skills assessments.

Ho: Students= attitude will not be significantly affected by the program.

Ha: Students= attitude will be significantly affected by the program.

CHAPTER 2

Characteristics of Quality Environmental Education Programs

Over recent decades, the number of environmental education materials available to educators has increased as environmental issues have become more and more important to the public. This has given the classroom teacher many choices of free and inexpensive materials and programs to use with their students. Many organizations, corporations and other groups have taken advantage of the need for educational materials and have sometimes used these materials to promote their viewpoints, awareness, and create empathy for their position. Due, in part, to a number of these programs, the environmental education community has come under attack for creating an atmosphere of concern based on emotion rather than teaching sound environmental science. As a result of this concern, major efforts have been made by environmental educators and the groups they represent to carefully examine the materials they use and distribute. Many characteristics have since been offered to describe quality environmental education materials. A brief overview of some of these characteristics is presented in Table 1.

Terminology describing pedagogical methodology and approaches to science teaching can often be complicated or vague in meaning. For instance, inquiry-based science is frequently used to describe very different types of science instruction and is the source of numerous publications and papers. It is often easy to overlook subtle distinctions between seemingly similar teaching methods such as inquiry and experiential learning. However, for purposes of this project, the broader definitions of terminology are used, revealing some general trends.

Three themes can be seen in the characteristics described in Table 1: knowledge, skills and attitude. Program materials used to increase student knowledge through environmental education must include characteristics such as instructional soundness, fairness, accuracy and depth (NAAEE, 1996).

Table 1. Characteristics of successful and effective environmental education materials and programs.

Guidelines Source	Educational Focus	Environmental Science Focus
Guidelines for Excellence (NAAEE, 1996)	∃ Emphasis on Skill Building ∃ Instructional Soundness	∃ Fairness and Accuracy ∃ Depth ∃ Action Orientation
Standards-Based Education and Its Impacts on Environmental Science Education (Davis, 2000)	∃ Developmentally Appropriate ∃ Interdisciplinary ∃ Inquiry-Based Experiences	∃ Ecologically Based ∃ Based on Local Ecoregions with Global Meanings ∃ Experiences in Natural and Impacted Environments ∃ Develop Environmental Ethic
Closing the Achievement Gap (Lieberman & Hoody, 1998)	∃ Interdisciplinary Collaborative Instruction ∃ Problem Solving and Project- Based ∃ Independent and Cooperative Learning ∃ Learner Centered	(not addressed by author)

In *Standards-Based Education and Its Impacts on Environmental Science Education*, Davis also includes characteristics for in knowledge acquisition seen in programs and materials that are ecologically based and use natural and impacted environments (Davis, 2000). Skills characteristics refer to those that help students build lifelong abilities and provide opportunities to apply those skills. These types of programs encourage critical and creative thinking. Building skills through problem solving, projects and interdisciplinary instruction (Lieberman and Hoody, 1998) are all methods that emphasize this characteristic. Students= attitudes toward environmental topics or issues of study are also important characteristics of effective environmental education programs. Developing an environmental ethic (Davis, 2000) in students should include aspects of knowledge and skills, as well as opportunities to take action (NAAEE, 1996) and independent learning (Lieberman and Hoody, 1998). Student experiences in natural and human impacted environments (Davis, 2000) provide opportunities for students to gain knowledge, skills and develop attitudes that cannot be achieved in a traditional classroom. These types of first-hand experiences help students develop an environmental ethic that forms the basis of a personal commitment. It is hoped that from this commitment, some form of positive environmental action will develop (Davis, 2000).

Other aspects of quality environmental education programs that address these three themes present environmental education instruction as a combination of many approaches including outdoor, nature-study, conservation and elementary science education. Seen again is the mention of an interdisciplinary approach that is strongly connected to other knowledge and skills that students are learning. Davis expands on these ideas by noting that environmental education programs should use ecologically based materials for students that include a strong emphasis on systems, noted as a basic standard in both the National Science Education and National Geography Standards (Davis, 2000). Davis goes on to expand on this guideline by citing that environmental education must be based in the local eco-region of the student and be able to extend this learning to a global scale.

Closing the Achievement Gap, the report given by a nationwide study focusing on the use of the environment as a context for learning provides guidelines that cover a broad range of types of projects and learning situations. While Environment as an Integrating Context (EIC) is not primarily focused on teaching and learning about the environment, it does examine the use of a school=s surroundings which typically includes environmental topics. It should be noted that the resulting features of successful EIC programs have common themes and characteristics of those found describing environmental materials and programs. Instructional approaches listed by the EIC study, including using interdisciplinary and collaborative learning approaches and project-based and learner-centered investigations which resulted in benefits such as improved performance on standardized tests and an increased enthusiasm for learning (Lieberman and Hoody 1998).

The Role of Informal Science Education

Informal (non-school-based) environmental education recognizes the need for supplemental and supporting science resources and has played a large role in helping to develop scientifically and environmentally literate students. Federal, state and local agencies, nature centers, botanical gardens, zoos and research facilities have educational programs designed to move teachers and students toward this goal. These types of organizations have made use of innovative pedagogical methods such as project-based, inquiry and experiential learning in their educational programs. Many of these organizations include a large number of hands-on activities, the use of subject matter relevant to students= everyday lives and engages students by allowing them to become active participants in changing the way the world works (Lieberman, 1995). Often these organizations also incorporate the use of outdoor sites as a supplement to or a replacement for the traditional classroom. Using outdoor learning sites gives students the opportunity to experience their environment through more of their senses and exposes them to daily life situations which creates a natural and relevant learning experience (Scheirloh, undated). Two of the most recognized curriculum guides for environmental education, used by both informal and formal educators, are Project WILD and Aquatic Project WILD from the Western Regional Environmental Education Council. These programs devote a section of each of the guides to outdoor learning, stating that the most fundamental reason for teaching outdoors whenever possible is that nature itself is the subject. The subject of study in environmental science is most often found in the living world or nature and people=s interactions with it. It is increasingly important, as population trends shift from rural to urban and suburban areas, to make sure that students have meaningful, first-hand experiences with the living world (American Forestry Association, 1999).

By recognizing the need for teacher support in environmental education, the majority of these environmental education organizations implement a Atop-down≅ approach to their environmental education programs that directly affect teachers and their students. Organizations do this by providing curriculum, teacher education and by implementing classroom programs that comprise as much as 57 percent of the total environmental education programs= content. Overall, the highest priorities are teacher education through in-service opportunities and providing environmental education curriculum materials (Lieberman, 1995). Among the environmental topics chosen by these organizations, three of the six most common focus on some aspect of water pollution and ecology (Lieberman, 1995).

While informal and supplemental environmental education has played an important role in assisting teachers and schools with environmental education, there are areas of these programs that can be improved and/or changed. A national survey of informal education programs suggests that these organizations need to become team members with formal education systems (Lieberman, 1995). To accomplish this, informal educators must begin to view environmental education from the formal (classroom-based) educator=s view. In order for informal educators to meet the objectives of environmental education and develop better communication between these two groups, co-planning and a better understanding of the objectives of each group (Parry, 1999) should be implemented. This will result in an increased understanding of each group=s perspective and can include continuing teacher education so that formal educators also become familiar and comfortable with the philosophy and organization of the program and/or curriculum of the informal educator.

Surface Waters Curricula

Based on the need for a partnership between the informal and formal educators, hundreds of programs are available to teachers offering a wide range of topics and teaching styles. Water issues are widely addressed by many programs reflecting the accepted importance of this resource. Understanding the systems that interact with and affect the functioning of our planet is paramount to its inhabitants. Adults and students often hold misconceptions about watersheds and river and stream systems. Often they have difficulty understanding how the ecology of these systems affects the water they may take for granted (LHS, 1997; ZPG, 1999). Our aquatic resources are highly manipulated to control flow, to generate power, to be available for irrigation and recreation, and yet many students are not aware of these issues and their impact on ecosystem functioning (NEETF, 1998). For example, according to a recent National Environmental Education & Training Foundation (NEETF)/Roper Starch Survey of environmental knowledge and myths, less than half of the adults surveyed could correctly identify the definition of a watershed and only 22 percent of Americans know that run-off is the most common form of pollution in streams, rivers and oceans. Almost half of those surveyed incorrectly believe that factories/industry are the source of the majority of water pollution (NEETF, 1998).

In an attempt to provide education that addresses misconceptions such as these, several excellent curriculum programs focusing on water issues have been developed and used by teachers across the country for the last 10 to 15 years. The Izaak Walton League of America has several guides available to teachers and the public regarding stream bank restoration. Save Our Streams (SOS) provides citizens= and teachers= guides focusing on basic water quality, biomonitoring and hydrology information that is specifically geared towards streams (Firehock & Doherty, 1995). The SOS program is unique because it provides a detailed guide for stream bank restoration geared toward citizens. Other surface water curricula including Project Learning Tree (American Forestry Department), WET Instruction Book (Texas Natural Resources Conservation Commission) and Project Aquatic WILD (Western Regional Environmental Education Council) provide more general education curriculum guides for students in grades kindergarten through twelve. Topics covered in these programs include water quality, land use issues and point and non-point pollution. They include many activities developed for use in an outdoor setting designed to concretely present information to students, giving them a first-hand view of the natural world.

These curricula are often available to teachers only after they complete education workshops in each program. Some also give a general overview of how to plan student action or long-term projects as a supplement to the individual activities and lessons. These programs have been tested extensively by both informal and formal educators and have emerged as prominent supplemental programs used throughout Texas and North America.

Pedagogical Methods for Science Teaching

Current research indicates that inquiry-based learning is an effective method of helping students reach the goal of scientific literacy. Inquiry learning is based on the idea that students learn best by investigation that is relevant to their lives (National Academy of Science, 1999). This method of instruction incorporates students= attitudes, science processes, and knowledge to assist students in developing the ability to reason and think critically (Martin et al., 1997). This method also suggests that science instruction must function elastically; that it should always be presented on as personal a basis as possible to insure that these experiences ultimately help the student understand the fundamental scientific concepts and principles. Promoting inquiry through activities, lessons and curriculum shifts the focus away from some traditional ideas of learning and toward more student-centered investigations. The National Science Education Standards proposes several changes in emphasis so that the inquiry method can be integrated into science education. These changes include the integration of all aspects of science content while studying just a few fundamental concepts. Inquiry activities are designed so that the teacher acts as a facilitator guiding students to use investigations to discover and analyze questions for themselves. Investigations over extended periods of time are also encouraged so that multiple process skills and communication can be fully developed. These long-term investigations also allow for more development of understanding, knowledge of content and allow students to develop inquiry skills (Crocker, 1992).

State education agencies, environmental organizations and science educators have been striving to improve the state of general and environmental science education in Texas. They do this by defining and providing guidelines for producing scientifically literate citizens. Two important science education documents, the National Science Education Standards (NSCS) and the Texas Essential Knowledge and Skills (TEKS) include aspects of inquiry-based learning. The TEKS specify the use of tools and equipment as essential aspects of students= science learning. Middle and secondary schools are required to devote a minimum of 40 percent of science instruction to laboratory and fieldwork. This standard is also recommended for science instruction in elementary schools. As one of eight areas, NSCS=s Content Standard A (grades 5 through 8) is devoted entirely to science as inquiry, outlining the fundamental abilities and concepts science programs should include. These abilities and concepts are based on the cognitive, physical and emotional developments of these age groups.

Simply including inquiry and hands-on science in the TEKS does not guarantee these standards will be correctly implemented in state classrooms and Atrue≅ inquiry is often difficult to define and implement. Most recently, the state house of representatives passed Senate Bill 103 creating and implementing a TEKS-based Texas Assessment of Academic Skills (TAAS) science testing at grades 5 and 10 beginning in 2003. This sends an important message to school administrators in the state. Many times what is tested is what is taught, especially when the school is held accountable for the test results of their students. Including the students= performance on these tests as part of the state-wide school report card may help teachers and administrators place more of an emphasis on quality science instruction. Teachers that may have taken time away from science in order to focus on tested subjects such as reading, math and writing may find themselves lacking the knowledge and materials needed to provide worthwhile opportunities for quality science instruction. Curricula such as Portrait of Your Stream are designed to help teachers meet the standards set forth for quality science instruction.

Portrait of Your Stream Development: Fall 1998 B Spring 1999

The Botanical Research Institute of Texas (BRIT) is a non-profit research facility located in Fort Worth, Texas. It was formed to house the herbarium collection and botanical library donated by Southern Methodist University. The education department of BRIT frequently seeks local partnerships with other educational organizations in order to promote learning and conservation of Aour natural heritage≅. A collaboration between BRIT=s education department and the University of North Texas= Institute of Applied Sciences provided funding for a part-time intern position for the development, research and publication of the POYS program. BRIT also provided support in the form of teacher contacts through workshops, environmental educator meetings and personal encounters. During the Fall of 1998 through the Summer of 1999, materials were adapted, revised and created providing a basic outline for the Portrait of Your Stream manual and program. To assist in determining lesson and program success, student assessments, teacher questionnaires and other information acquisition methods were also developed.

Organization of Portrait of Your Stream

Portrait of Your Stream incorporated and adapted existing lessons, activities, models and other teaching materials from various sources. Lessons and activities were created to address concepts not found in existing curricula. The program was pilot tested by selected middle-school area teachers in the Fall semester of 1999. Both formal and informal assessments regarding the organization, methods, topics and content of each lesson/activity were made and adjustments were made accordingly. Student assessments of attitudes, knowledge and skills were administered prior to and following participation in the POYS pilot program.

The resulting program included a total of sixteen lessons, activities, field investigations and student action guide for students in grades six through nine. The program uses streams in North Central Texas as a study area. The program was designed to meet the objectives outlined in this paper as well as the needs of BRIT=s informal education program since the program will be administered through this organization. The Portrait of Your Stream is organized into two main teaching modules: (a) Stream Characteristics includes lessons and activities for water quality, stream physical and biotic characteristics, and (b) the Student Action and Restoration Guide provides information and application activities that provide a detailed outline of the steps required for restoring, reclaiming or further investigating local streams by students (see Fig.1). Originally, a pilot stream bank restoration project was planned for implementation in the Spring semester of 2000. This project was not implemented due to time constraints and teacher resources.

POYS classroom lessons and field activities were designed to introduce students to basic concepts in three areas of stream ecology: water quality, physical characteristics and biotic characteristics. Water quality topics include an introduction to types of water pollution including sources within the watershed, chemical testing of water including pH and dissolved oxygen and water quality and its effects on animals. Physical characteristics of streams studied include basic processes of erosion, illustration of urban watersheds using models and topographic maps and functional investigation of riparian zones. The third area of study, biotic characteristics, focused on the relationship between predators and prey, adaptations of animals in aquatic environments, biomonitoring methods and insect metamorphosis. Each of these three areas of study was designed to complement and support other areas so students would receive opportunities to apply their knowledge in several situations. For example, students studying different types of water pollution (Water Quality) and their sources will be able to reinforce this information when they began exploring urban watershed models and topographic mapping (Physical Characteristics). Once teachers have completed the classroom lessons and/or field activities they chose, students could proceed to further investigate, take action and apply their knowledge to improve a stream area. As the lessons were organized into three parts, so is the Student Action Guide of POYS (see Fig. 1). Students may choose to continue investigations in water quality, erosion or more open-ended investigations depending on the condition of the stream site and/or student interest. Field applications in each of the three areas of student action provided further opportunities to develop students= data collection skills, field techniques or long-term monitoring. Opportunities were also provided for students to share their knowledge with other students, school staff and administration or community members and to develop communication skills through public education projects. Students were also able to plan and implement a short-term or long-term project such as a stream clean-ups, restoration or other related projects.

Each study area of the Student Action/Restoration Guide in the POYS manual included outlines and suggestions for field assessments and two to four strategies for student action. The section of the POYS project was presented in an open-ended guide format that included detailed information for project planning and implementation. The individual activities within the program follow a lesson plan format designed for use by the classroom teacher. To provide additional resources for classroom lessons and field activities the program also includes Physical and Biotic Characteristics field manuals and data sheets, aquatic insect and plant identification mats and related classroom games. Each of the classroom lessons and field activities is presented in a uniform format organized with classroom teachers in mind. The following table lists components included in each lesson.

Figure 1. Concept Map of Portrait of Your Stream with areas of emphasis.

Portrait of Your Stream Curriculum
Classroom Lessons and Field Activities

Water Quality	Physical Characteristics	Biotic Characteristics
Types of Water Pollution	Erosion	Predator/Prey Relationships
pH Values	Watersheds	Animal Adaptations
Dissolved Oxygen	Topographic Maps	Biomonitoring
Water Quality & Animal Relationships	Riparian Zones	Insect Metamorphosis

Student Action Projects

Water Quality	Erosion	Student Guided Action
Field Application	Field Application	Field Application
Stream Clean-Up	Streambank Stabilization	Plant & Animal Diversity
Public Education	Public Education	Long-Term Monitoring
Long-Term Monitoring	Long-Term Monitoring	Other Actions

Table 2. Portrait of Your Stream Lesson Plan Components

POYS Lesson Components

∃ Lesson/activity objective	∃ Lesson materials list
∃ Areas of focus by science subject	∃ Additional resources (books, internet sites)
∃ Activity time and setting	∃ Safety concerns
∃ Teacher background information	∃ Lesson/activity procedure
∃ Coorelating TEKS, TAAS and National Science content Standards by grade level (grades 6-9)	∃ Student assessment
∃ Teacher Log and Student Generated Questions	∃ Optional activities/Going Further
∃ Data Sheets, Student Sheets, Overhead Masters and Graphic Organizers (as applicable)	

CHAPTER 3

Recruitment and Selection of Pilot-Study Teachers

Teachers recruited for piloting the Portrait of Your Stream (POYS) curriculum were chosen on the basis of interest or experience in teaching environmental science, specifically water issues. During the spring and summer of 1999, recruitment took place in the Fort Worth area during the Rainwater Foundation=s REAL People meetings, through meeting with teachers trained in BRIT=s Trinity River Watch program, and teachers affiliated with similar groups and organizations. Information about the program and pilot testing were distributed through fliers, personal encounters and letters to individual teachers (See Appendix A).

Teachers interested in participating in the pilot program were required to be a Fort Worth area classroom science teacher in a middle- or high school. Teachers who showed an interest in taking students to outdoor sites for lessons were given higher priority. Participating teachers were to asked to commit to teaching at least one of the POYS sections (water quality, physical characteristics or biotic characteristics) each lasting approximately six to eight class periods. Teachers interested in the Student Action section of POYS also needed flexible commitments of time in order to complete their choice of further investigative student projects. In addition to teaching the program, teachers were asked to administer three pre- and post program assessments of skills, knowledge and environmental attitude. Participating teachers provided both formal and informal feedback regarding the implementation, organization and content of the program. In return for participating in the pilot test of the program, teachers received individual training regarding the program=s organization, methods, background knowledge and training as a group of applied field techniques. Assistance in acquiring or producing any specialized equipment for field or classroom activities was also provided. In addition, all participating teachers received a final version of the Portrait of Your Stream curriculum at the end of the program.

A working first draft of the POYS curriculum was completed at the beginning of the summer of 1999 and teacher recruitment for the pilot program began at that time. The pilot program was designed so that participating teachers would implement and use portions of the program and curriculum with their students during the coming Fall semester. The pilot program was initially started with four teachers from two schools. Initial meetings were conducted with these four teachers. These meetings allowed teachers to receive detailed information about what the program entailed, their responsibilities and time frames. Due to logistical problems such as scheduling two participating teachers, both from the same school completed the final pilot program.

Pilot Program with Stripling Middle School

W. C. Stripling Middle school is located in Fort Worth, Texas. The school serves 703 students in grades six through eight (FWISD, 2000). Participating teachers (referred to as Teacher 1 and Teacher 2) were both members of the Trinity River Watch program (TRW). TRW is a collaborative program between BRIT, the Outdoor Learning Center (OLC) of the Fort Worth Independent School District and the Rainwater Foundation. This program provides teacher workshops, curricula and field trip support to middle-school teachers to conduct ongoing water quality monitoring of the Trinity River. The TRW program served as a forum for the training and implementation of POYS. Teachers involved in the TRW program attend educational workshops to learn content and techniques needed to take students on water monitoring trips to local streams and waterways in the Trinity River. The TRW leaders were interested in using the POYS program in conjunction with their current plans for the TRW project watershed (see Table 3).

Overview of Populations of Participating Students

Students of Teacher 1 (referred to as Group 1) include 103 eighth-grade students involved in regular education courses. These courses include but are not limited to prior involvement in TRW-type programs and modifications to assignments on the basis of learning styles and documented learning disabilities. Teacher 1 served as the regular science teacher for Group 1 and saw students three to four times a week.

Teacher 2 also served as the science teacher to twelve students (referred to as Group 2) who were in the school program for English as a Second Language (ESL) and participated in the pilot. These students received a modified curriculum designed to help facilitate their English speaking skills before continuing classes in the regular classroom. Because of the length of the program (over six months) there were students from both Groups who transferred in and out of the classes and/or the school. As a result of this as well as student absences, the number of students whose results are discussed in Chapter 4 will vary.

Participating teachers chose the scope, sequence and implementation schedule of the POYS program that best fit with their schedules, curricula and students= abilities. Teachers were asked to commit to at least one section of the POYS curriculum and teach all of the classroom activities during the Fall semester. Days spent observing at the school (Table 3) afforded that opportunity to teach some of the classroom lessons firsthand or in conjunction with the teacher. Field lessons and activities were conducted during water monitoring field trips (see Table 3) and were primarily led by the researcher with occasional activities led by Teachers 1 and 2, staff members from Fort Worth ISD=s Outdoor Learning Center and other TRW teachers. Table 3 summarizes the event activities taking place during the pilot program, locations and groups participating.

Overview of Field Trips

Due to weather and scheduling conflicts, some field trips were canceled. A total of four out of seven scheduled water monitoring field trips were actually implemented in the Fall semester. Students spent approximately four hours at the site during each visit, moving through four to five separate activity stations including stream physical characteristics, biomonitoring, water chemistry testing, rafting/water

Table 3

Joint collaboration events with the Trinity River Watch program and Portrait of Your Stream pilot program, Stripling Middle School, Fall 1999

Date	Event	Location	Participants
23 September 1999	Overview and planning of POYS program	Stripling Middle School	Stripling TRW teachers, BRIT staff and POYS program coordinator
24 September 1999	Program implementation and observation	Stripling Middle School	Stripling participating POYS teacher, Stripling students, POYS program coordinator
30 September 1999	Water monitoring field trip	Trinity River at Bryant Irvin Rd.	TRW teachers, Stripling students, OLC staff, POYS program coordinator
13 October 1999	Program Implementation and observation	Stripling Middle School	Stripling participating POYS teacher, Stripling students, POYS program coordinator
15 October 1999	Program Implementation and observation	Stripling Middle School	Stripling participating POYS teacher, Stripling students, POYS program coordinator
18 October 1999	Water monitoring field trip	Heritage Park at Lake Benbrook, Ft. Worth, TX	TRW teachers, Stripling students, OLC staff, POYS program coordinator
25 October 1999	Water monitoring field trip	Ft. Worth ISD Outdoor Learning Center	TRW teachers, Stripling students, OLC staff, POYS program coordinator
8 November 1999	Water monitoring field trip	Trinity River at Bryant Irvin Rd. Ft. Worth, TX	TRW teachers, Stripling students, OLC staff, POYS program coordinator
January/February 2000	Program implementation and observation	Stripling Middle School	Stripling Participating POYS teacher, Stripling

			students, POYS program coordinator

Overview of Field Trips

Due to weather and scheduling conflicts, some field trips were canceled. A total of four out of seven scheduled water monitoring field trips were actually implemented in the Fall semester. Students spent approximately four hours at the site during each visit, moving through four to five separate activity stations including stream physical characteristics, biomonitoring, water chemistry testing, rafting/water safety, and journaling. Three to four classes of students in grades six through eight attended the each of the field trips. Students had the option of signing up to go on more than one of the trips, so that on any trip there were some experienced students and some students new to the program. Requirements for the students to be allowed to attend the trips were to have all schoolwork from all teachers up to date, acceptable behavior recommendations from their teachers and a signed consent form from their parents. Students were also asked to sign a form outlining trip rules and student responsibilities.

Methods and Materials

Prior to the beginning of the pilot program, participating teachers were provided with copies of the POYS manual and were briefed regarding the content and program requirements. Each teacher was directed to a ATeacher Feedback Form≅ following each lesson and was asked to comment on successful aspects of the lesson and to make suggestions for improvement and copies of any revisions or adjustments they made to the lesson. Teachers were also asked to administer a three-part, thirty-question test, to be given before the classroom or field lessons were presented to the students. Teachers were given a master copy of the three assessments (Knowledge, Skills and Attitude).

Based on information provided by teachers regarding the portions of POYS they would teach, the Knowledge assessment included ten questions covering topics including introductory concepts of watershed, topographic map interpretation and biotic characteristics of a stream. Answers for questions on the Knowledge assessment were provided in a multiple choice format, lettered A,B,C or A,B,C,D. A variety of answer combinations were provided such as ATrue≅, AFalse≅ and AI Don=t Know≅ as well as AAll of the Above≅ and ANone of The Above≅. Each question had one most correct answer provided for students to choose. AI Don=t Know≅ was not counted as a correct answer, but was included to allow students to have a choice of an answer to discourage a perception of being Awrong≅. This strategy was used specifically with the pre-assessment in mind due to the lack of background knowledge students were likely to have on these topics. Questions were graded on a percentage scale and scores were rounded to the nearest tenth. One question on pH values of liquids was omitted from data analysis due to inconsistencies of answer choices.

The skills assessment included nine questions, seven of which were counted toward assessment results data. The format of this assessment was written primarily in open-ended questions followed by a blank space provided for student answers. One question provided three choices of answers to label four types of pollutants. Topics of the Skills assessment included story problems focusing on assessing health of an organism, measuring stream velocity, averaging values, contrast/comparison and opportunities to support answers relating to nutrient cycles. Skills assessment answers were graded using a rubric with each answer receiving a score of 1 (lowest value) through 4 (highest value). These scores were then converted into a percentage and rounded to the nearest tenth in order to be consistent with Knowledge scores. Two questions from this assessment were not used due to the lack of materials in teacher classrooms.

The Attitude assessment included ten questions focused on finding out how often students thought about water pollutants, to what degree they felt concern and interest in water quality issues and stream ecosystems and the degree of knowledge they felt they had about these topics. These questions were written in the first person to facilitate answers that reflect student=s own opinions. This was done to encourage students to provide answers of how they actually think rather than reflect answers of how they would like to seen by others. Students were given a choice of four letters A through D and each question was graded by correlating the letter with a value of 1 (most negative response) through 4 (most positive response). These values were not converted to percentages and averages were rounded to the nearest tenth. All questions in the Attitude assessment were used in data collection.

After pre-assessments were administered, teachers were asked to provide anonymous samples of student work for each of the lessons. These samples were to be used as informal qualitative guidelines of typical student work in order to assess areas of confusion, vague instructions or clarity of questions. Contact with teachers was conducted on a weekly to biweekly basis through phone calls, email, school visits and during field trips. Progress and problems with the pilot program were discussed during these times and changes were made accordingly.

Due to time constraints, teaching schedules and miscommunication, several aspects of the teacher requirements were not followed. The most significant example of this was the administration of the Skills Assessment to only one class (twenty-five students) instead of administration to all classes (approximately one hundred fifteen students). Other program terms not followed include a lack of student sample work received from teachers and the extension of the pilot program well into the Spring semester (2000) instead of completion by the end of the Fall semester (1999).

In hindsight, deeper appreciation and understanding of the importance of teacher schedules, especially schedule changes beyond their control, would have helped to alleviate some problems with the pilot program implementation. It is difficult to plan for all problems that arise with schedules, however clearer communication on my part as well as fewer requirements of participating teachers overall would have been most helpful.

CHAPTER 4

Quantitative Data Assessment

The limited number of interested teachers who could actually complete the pilot program restricted initial development of this research project. Because information regarding the student populations participating in the program were not initially known, hypotheses developed were purposefully general. However after gaining knowledge regarding participating students, implementation of the pilot program and the number of participating of students and teachers, other areas of study developed. The next sections of this chapter will present and discuss results of the Knowledge, Skills and Attitude assessments of different student populations. Following these results will be acceptance or rejection of the research project hypotheses and discussion of program results.

Group 1 (refers to students of Teacher 1 in regular classes) had the largest number of students (n = 105). These students also had a choice of how many field trips to attend. Because of these factors, data of subgroups of gender, assessments and number of field trips attended will be compared. Group 2 (refers to students of Teacher 2 in English as a Second Language classes) included a much smaller number of students (n = 12) and because all students attended all four field trips, only comparison of differences in assessments and gender results are presented. Results of student assessments will be presented and discussed in the following ways:

Table 4

Organization of subgroups for comparison of pre- and post-assessment results

Differences in Pre- and Post-Assessments	
Group 1	Group 2
Differences in Knowledge Assessment (Male to Female)	Differences in Knowledge Assessment (Male to Female)
Differences in Skills Assessment (Male to Female)	Differences in Attitude Assessment (Male to Female)
Differences in Attitude Assessment (Male to Female)	
Differences in Knowledge Assessment (# of field trips attended)	
Differences in Skills Assessment (# of field trips attended)	
Differences in Attitude Assessment (# of field trips attended)	

Knowledge Assessment Data

The values in Table 5 were calculated by averaging all Knowledge pre-assessment and post-assessment scores for each student in Group 1. Pre/Post Differences were calculated by subtracting each student=s pre-assessment score from their post-assessment score. Differences were then averaged for the Group. Positive, negative and no differences were included in the averages. If a student was present for one test (i.e. the pre-assessment) but absent for another test (i.e. post-assessment) their scores were included for the Assessment averages but were omitted from the Differences averages.

Overall students in Group 1, the largest and most diverse group in the study, improved their Knowledge assessment score an average of 13.8 percentage points. The average pre-assessment score for Group 1 is 36 percent (n = 105) and scores on the post-assessment after participation the POYS program is 49 percent. Male and female students produced average scores that were within a few points of each other. While these subgroups varied in size due to absences, performance on the pre-assessment by male and female students is 36 percent and 35 percent respectively. A general overview of performances of Group 1 on the Knowledge assessment is given in Table 5.

Table 5

Group 1 Knowledge Assessment Results and Comparisons

	Whole Group	Male	Female
N	105	53	52
Pre-assessment average	36%	36% (n = 51)	35% (n - 51)
Post-assessment average	49%	49% (n = 51)	49% (n = 52)
Pre/Post difference average	+13.8 percentage points	+11.7 percentage points (N = 49)	+14.8 percentage points (N = 51)

Group 2, the much smaller ESL class, had Knowledge assessment averages similar to those of Group 1 (Table 6). Overall as a class, Group 2 had an average of 7.0 percentage points difference between the pre-assessment average (34 percent) and post-assessment average (41 percent). Male and female subgroups in Group 2 scored within two percentage points between both the pre- and post-assessments. Male students in this class increased their performance on this assessment 0.7 percentage point over female students (7.3 and 6.6 percentage points difference respectively).

Table 6

Group 2 Knowledge Assessment Results and Comparisons

	Whole Group	Male	Female
N	12	7	5
Pre-assessment average	34%	33% (n = 7)	35% (n - 5)
Post-assessment average	41%	40% (n = 7)	42% (n = 5)
Pre/Post difference average	+7.0 percentage points	+7.3 percentage points (n = 7)	+6.6 percentage points (n = 5)

Skills Assessment Data

Skills assessment averages for both Group 1 and 2 reveal less information about the effect of the POYS on specific student skills. Differences in the pre- and post-assessment for Group 1 includes only twenty-five students total (Table 7) due to the limited number of pre-assessments administered prior to the POYS program.

Skills averages for Group 1 (Table 7) in both the pre- and post-assessment scored higher than in the Knowledge assessment, however the Pre/Post Differences average was almost ten percentage points lower. Although Group 2 (Table 8) was not given the Skills pre-assessment prior to the POYS program, post-assessment averages indicate higher averages for the class and both subgroups when compared with this group=s Knowledge post-assessment averages.

Table 7

Group 1 Skills Assessment Results and Comparisons

	Whole Group	Male	Female
N	n/a	n/a	n/a
Pre-assessment average	65% (n = 25)	65% (n = 14)	63% (n - 11)
Post-assessment average	70% (n = 103)	67% (n = 55)	72% (n = 50)
Pre/Post difference average	+4.5 percentage points (n = 25)	+5.3 percentage points (n = 14)	+3.5 percentage points (n = 11)

Table 8

Group 2 Skills Assessment Results and Comparisons

	Whole Group	Male	Female
N	11	6	5
Pre-assessment average	n/g[a]	n/g[a]	n/g[a]
Post-assessment average	60% (n = 11)	58% (n = 6)	63% (n = 5)
Pre/Post difference average	n/a[b]	n/a[b]	n/a[b] (N = 51)

[a] Student assessments not given to students. [b] Averages not available.

Attitude Assessment Data

Averages for Attitude assessments are not based on percentages due to the rubric method used. These scores are presented on a scale of 1 through 4, with each number representing the most negative response (1) to the most positive response (4). Each Group=s scores were averaged and calculated again to obtain a final average. Because of the small scale of these values the final averages were rounded to the nearest hundredth (Table 9).

Unlike the Knowledge and Skills assessments, where there was an increase in scores from pre-assessment to post-assessment, Attitude assessment values decreased for Group 1. As a whole, Group 1 had a 0.11 point decrease in Attitude averages. Male and female students in this group had pre- and post-assessment scores above or equal to 2.80 and both subgroups decreased in this area, although the female group decreased scores by only five hundredth of a point. The largest negative Difference average in Group 1 belongs to the male subgroup (-0.14).

Table 9

Group 1 Attitude Assessment Results and Comparisons

	Whole Group	Male	Female
N	103	52	51
Pre-assessment average	2.88 (n = 98)	2.80 (n = 51)	2.97 (n - 50)
Post-assessment average	2.78 (n = 100)	2.67 (n = 52)	2.91 (n = 50)
Pre/Post difference average	-0.11 (n = 98)	-0.14 (n = 50)	-0.05 (n = 51)

In contrast to Group 1=s performance on the Attitude assessment, Group 2 had positive Differences averages in both subgroups with males increasing their scores the most. Group 2 pre-assessment averages in both subgroups were lower than Group 1=s pre-or post-assessment averages. Group 2 had increased post-assessment Difference averages as a whole and in both subgroups were increased over one half point

(Table 10).

Table 10

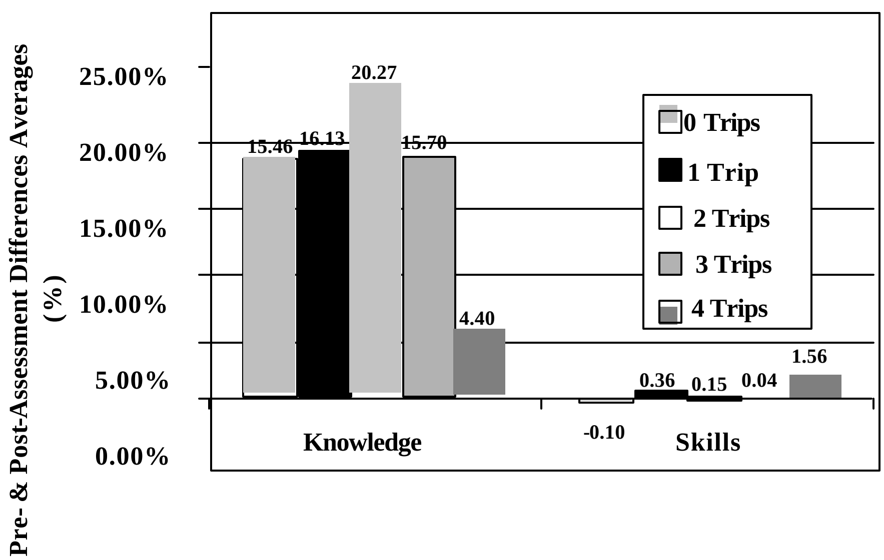
Group 2 Attitude Assessment Results and Comparisons

	Whole Group	Male	Female
N	11	7	5
Pre-assessment average	2.49	2.54 (n = 5)	2.45 (n - 4)
Post-assessment average	3.03	3.12 (n = 7)	2.94 (n = 5)
Pre/Post difference average	+0.64	+0.76 (n = 5)	+0.52 (n = 4)

Figure 2 shows a comparison of the difference in pre- and post-assessments for the Knowledge and Skill portions of the assessment based on the number of field trips attended by students in Group 1. The largest of these subgroups (n=54), those attending no field trips, gained 15.46 percentage points on the Knowledge assessment. Groups attending one trip (n=15) and three trips (n=7) had similar gains differing by a little more that one half point at most. The largest gain in Knowledge assessments belong to students that attended two trips (n=22) while the smallest gain occurred with students who attended all four trips (n=5).

Figure 2.

Pre- and Post-Assessment Difference Average by Number of Field Trips Attended.



The field trips focused on activities using skills that were targeted on the Skills assessment and students who did not attend any field trips showed a decrease in differences in Skills assessments (-0.10 percentage point). Students attending one, two or three trips had some gain in skills averages (0.36, 0.15 and 0.04 percentage points respectively) while students attending all four trips had the highest gain of 1.56 percentage points.

Hypotheses Testing

Five null hypotheses were developed and presented prior to the pilot program of Portrait of Your Stream. Because of the nature of the student populations participating in the POYS pilot program, each hypothesis will be accepted or rejected for Group 1 and Group 2. The following section is a listing of these hypotheses with an explanation as to whether each can be rejected or accepted.

Hypothesis One:

Ho: Student performance on knowledge assessments will not be significantly affected by the program.

Differences values for both Groups 1 and 2 were calculated by subtracting scores, noting a positive or negative difference. Values were then tested for normality (Shapiro-Wilk) and if assumptions were met, were subjected to a matched pair Student=s *t* test. If assumptions were not met, the non-parametric Wilcoxon matched pair test was used.

Group 1 Results:

Group 1 difference values were significantly different from a normal distribution (Shapiro-Wilks, p=0.0029), therefore the Wilcoxon test was used. Knowledge difference values for each student were ranked and noted as being a positive or negative difference. Positive and negative sums were calculated and compared with the Wilcoxon *t* value ($T_{0.05(2)103}$). Results from this test indicate that there is a significant difference in Knowledge difference scores prior to and after participation in the POYS program (Wilcoxon, $T_{0.05(2)103} > t=663.4$) . Therefore null hypothesis one is rejected for Group 1.

Group 2 Results:

Difference scores met assumptions for the Student=s *t* test, which was used for Group 2. Results from the Student=s *t* ($p=0.2076$) test indicate that there was no significant difference in scores prior to and after participation in the POYS program. Therefore null hypothesis two is accepted for Group 2.

<u>Hypothesis Two:</u>

Ho: Student performance on skills assessments will not be significantly affected by the program.

<u>Group 1 Results:</u>

Group 1 Skills assessment difference values met assumptions for the Student=s *t* test. Results from the test indicate that there is a significant difference in student skills assessment scores prior to and after participation in the POYS program ($p=0.0480$). Therefore null hypothesis two is rejected for Group 1.

<u>Group 2 Results:</u>

Pre-assessment Skills tests were not given to Group 2 prior to the POYS program and therefore cannot be analyzed.

<u>Hypothesis Three:</u>

Ho: At least eighty-five percent of participating students will not achieve 70 percent or better on knowledge assessments.

<u>Group 1 Results:</u>

Student scores for Knowledge pre- and post-assessments were graded and averaged for Group 1. Scores were then examined to determine the number of students with a score of 70 percent or better for each assessment. 3.8 percent of students in Group 1 scored above 70 percent on the Knowledge pre-assessment and 11.6 percent of students scored above 70 percent on the post-assessment. Therefore null hypothesis three is accepted.

Group 2 Results:

Student Knowledge assessment scores for Group 2 were calculated in the same manner as Group 1. No students achieved above 70 percent on the Knowledge pre-assessment or post-assessments. Therefore null hypothesis three is accepted for Group 2.

Hypothesis Four:

Ho: At least eighty-five percent of participating students will not achieve 70 percent or better on skills assessments.

Group 1 Results:

In Group 1, 36 percent of students scored above 70 percent on the Skills pre-assessment and 55.3 percent scored above 70 percent on the post-assessment. Therefore null hypothesis four is accepted for Group 1.

Group 2 Results:

No Skill pre-assessment was given to Group 2 prior to participation in the POYS program. 33 percent of students In Group 2 achieved scores of 70 percent or higher on the Skills post-assessment. Therefore null hypothesis four is accepted for Group 2.

Hypothesis Five:

Ho: Students= attitude will not be significantly affected by the program.

Group 1:

Difference values for Group 1=s Attitude assessment met assumptions for the Student=s *t* test. The test results indicate that the attitude differences after participation in the POYS program are significantly different from prior attitudes (Student=s *t*, p= 0.0137). Therefore null hypothesis five is rejected for Group 1.

Group 2:

Group 2 Attitude assessment difference values also met assumption for the parametric test. The Student=s *t* test indicates that the attitude differences in students after participation in the POYS program are significantly different from attitudes prior to the program (Student=s *t*, p=0.0051). Therefore, null hypothesis five is rejected for Group 2.

CHAPTER 5

The purpose of this research project was twofold: to determine the process of creating and implementing a quality environmental education program and to assess students= knowledge, skill and attitude as they related to the POYS program. As outlined in Chapter One, the nature of such as project includes a wide range of variables, some anticipated and some not. The following sections present a discussion of both quantitative and qualitative results of both the POYS pilot program and research project.

Knowledge, Skill and Attitude Assessment Results

Overall, students in both groups had increased performance on the Knowledge portion of the assessments. Group 2 also had increased scores on the Skills assessment, however not to the same degree. This may be due to several factors. Creating test questions is a science unto itself and differences in the difficulty levels, content or presentation of questions most likely affected scores. The Skills assessment responses were also graded using a rubric, which is a more subjective method than a four-choice answer scheme.

There were slight differences in performances of male and female students in both the Knowledge or Skills assessment. Group 1 female students performed an average of 3.1 percentage points higher on the Knowledge post-assessment than on the pre-assessment. Male and female students in Group 2 had only 0.7 of a percentage point difference in their average scores. Group 1 male students, on average, scored 1.8 percentage points higher than female students did on Skills assessments, with no data for Group 2.

There was, however, a dramatic difference between Group 1 and 2 in the Attitude portion of the assessment. Students in Group 1, especially males, had a decrease in positive comments and views after participating in the POYS program. This may be due to several factors. One can speculate that because the program lasted for a longer period of time than planned that students tired of have to Aget through≅ the classroom lessons in order to be finished with the program. Another explanation may be that students did not respond favorably to the presentation of classroom lessons and/or field activities. Further investigation to the reasons why there was a decrease in positive attitudes after the program would be beneficial in confirming effective environmental education programs.

In contrast to Group 1, Group 2 had a marked increase in positive attitudes after participation in the POYS program. It was the male students who increased their overall Attitude score (+0.76 points) the most, with female students also increasing scores +0.52 points on average. Of course, this was the outcome that was hoped for and examination of factors leading to the results is worthwhile. I had an opportunity to work with both Group 1 and Group 2 two times in the classroom, presenting classroom lessons and administering post-assessments. The tone of the classroom in Group 2 seemed much more upbeat and positive that in classes comprising Group 1. Students in Group 2 asked more questions during and after the lesson while students in Group 1 seemed content to finish what they were required to do and move on to another task. There was no instrument to measure the impact the effect the classroom environment may have had on the assessment results of the POYS pilot.

It may be interesting to note that Group 2 students were relatively new to this country and over half of these students came from Serbia and Croatia. Teacher 2 reported that many of these students came from areas of these countries where violence was common and some students had escaped from dangerous areas. The presentation and content of public education these students received at Stripling Middle School was most likely in sharp contrast to that of their native country. A comparison of Group 2=s attitudes in other subject areas or one on one interviews with students may provide interesting information regarding the differences found in attitude. Other variables leading to the differences in these attitudes, including teacher presentation styles before and during the lessons, may also provide information on the results of these groups.

Hypotheses Results

The hypotheses tested were designed to examine attitudes of participating students as well as the growth of understanding of the topics covered during the program. Like the unexpected variables experienced, some assumptions were made at the time the hypotheses were developed but were not realized during the pilot program. An important assumption was that the time frame of student participation in the pilot program would be limited to three and one half months or the Fall semester 1999. Because of problems discussed earlier in this paper, the classroom activities and post-tests were not administered until January (Group 1) and February (Group 2) of 2000. Again, it was thought that keeping the program limited to a shorter time period would allow students to experience class POYS lessons while they were attending the water monitoring field trips. Instead, four to five months passed between the pre- and post-assessment and students were still receiving new information well after a winter holiday break. The effect of the extended time frame on student attitude is unknown, however results from both Groups were lower than expected.

Another major variable in the assessment of the POYS pilot program may have been the scope and format of the three assessments. Future studies focusing on similar objectives such as those presented in this paper may need to be more narrowly defined and limited to one of the three aspects tested here. This would provide focus to content and format and reduce the variability of assessment questions.

Informal Assessments

Opportunities to work with students in small groups and individually allowed me to observe students during various phases of the POYS program. Observations, informal interviews with students, and additional informal student comments provided information to assess the level of environmental literacy defined by Disinger and Roth (see Chapter 1). Out of the three levels (nominal, functional and operational), it is believed that the majority of participating students began the program at the lowest nominal literacy level. Students were placed at this level because many students had no concept of the topics addressed and were not familiar with terms used in the program. Several students commented that they had never heard of the term Awatershed≅ and were unclear of its meaning. At least ten students reported that they have never visited a Areal≅ stream before and were surprised by the variety of organisms they found living in the water.

One of the most interesting encounters occurred during a conversation with an eighth-grade student. As she was examining the contents of her kick net sample of the stream substrate, she came across an unfamiliar animal. She asked me for assistance in identifying it. I presented open-ended questions similar to those listed below, hoping that the clues she noticed would lead her to the answer.

AWhat do you see?≅

AIt has a shell.≅

AOkay, what else?≅

AIt has a little thing sticking out of it Blike a tail.≅

ADo you have any guesses about what it is?≅

AIs it a turtle?≅

Although the student had successfully used her observational skills to find clues about the animal, it was clear that her lack of background knowledge, experiences in stream settings and aquatic animals did not provide her with the correct answer. The animal she identified as a turtle was instead a small aquatic snail.

Research Project Objectives

As previously mentioned, the quantitative aspects of the POYS pilot program were only part of the overall research project. Other major objectives included researching existing water quality curricula and creating quality education material presented in a teacher-friendly format.

Table 1 (Chapter 2) summarized characteristics of successful and effective environmental education materials and program. Through responses collected during informal interviews, reviews and participating teacher feedback, it is believed that the POYS curriculum successfully addressed several of these components. Throughout the water monitoring field trips there was an emphasis on skill building through data collection and field techniques as well as student action through stream bank clean ups. Information in both field work and classroom lessons was presented in an interdisciplinary format. For example, lessons frequently incorporated math skills and reflective journaling. The POYS was an ecologically and locally based program providing opportunities for students to learn about concepts such as a watershed in the classroom and then experience them by working in area stream systems. These areas were also examples of natural and impacted environments, allowing students to see the effects of humans on stream systems. Finally, classroom lessons and field activities were presented through collaborative instruction allowing students to experience different perspectives on issues and different styles of teaching. This collaborative instruction also allowed the program to take advantage of teachers= areas of expertise.

POYS Curriculum Objectives

There are also many proposed objectives pertaining specifically to the design and content of the actual POYS curriculum. Although not all objectives were met to the same degree, most of the characteristics of the POYS program reflect an overall facilitation of environmental awareness. Many students in the program reported they had never experienced a Areal≅ stream before and several had never been outside of their own urban neighborhood.

While the data may not reflect the numbers of increased positive attitudes expected, there were many students for which this was an eye-opening experience. Students also responded positively to another project objective -contributing to data collection that had a purpose and was an on-going project providing information that people would actually use. Students had the opportunity to comment on Awhat they know about streams≅ both before and after participation in the POYS program. Responses prior to the program included a majority of blank answer areas or AI don=t know≅. Responses after the program increased overall and reflected an increase in knowledge of organisms living in the stream, how water flows in a stream system and concern with water quality and pollutants. These comments also provided information regarding students= continued misconceptions about nutrient cycling in the stream and sources of pollutants.

Another more general objective for the whole project is that it would be of use to teachers and other educators. After revision of the POYS program, based on feedback from teachers and information gathered during the pilot program, the manual is now in a final form and had been distributed to over 20 educators through out the state. Plans have been made to translate portions of the program into Spanish to use with an international teacher-exchange program. The POYS program is also offered as a part of the Botanical Research Institute of Texas= environmental education resources.

In conclusion, the Portrait of Your Stream curriculum, pilot program and research project demonstrated various levels of success. Results indicating negative attitude development and lower than expected post-assessment scores may have more to do with assessment tools, presentation of lessons and activities and length of program than program content. Qualitative results including the development of a final Portrait of Your Stream manual and program indicate successful completion of major objectives. Overall it is hoped that the amount of information gained from completing a project of this scale and nature will be of use to educators interested in providing quality environmental education materials to environmental stewards and decision-makers of the future.

APPENDIX A

TEACHER RECRUITMENT LETTER

May 12, 1999

Dear ,

I am an UNT graduate working with Charlotte Bryant at the Botanical Research Institute of Texas (BRIT) creating educational programs focusing on stream ecology and restoration for middle-school (6^{th}-9^{th} grades) students. I would like to invite you to be part of our pilot program by implementing some of the curriculum we have developed with your students.

We are currently looking for teachers who would be interested in working with me so that we can begin the testing phase for our APortrait of Your Stream≅ program. The enclosed flyer gives an overview of what the curriculum includes. The program includes a fairly extensive range of classroom and outdoor activities focusing on physical, plant and animal (mainly aquatic insects) characteristics and water quality of a stream. The culminating activity is a stream restoration project based on the initial assessments of the stream. This restoration can take many forms, from picking up the trash in and along the stream to actually utilizing some bioengineering techniques to stabilize the banks.

Portrait of Your Stream was designed by taking concepts covered in the Trinity River Watch program to create specific lessons and filed opportunities written in a lesson plan format. Although teachers participating in this pilot study will be able to choose from any of the modules, the Portrait of Your Stream program is designed with a final restoration project in mind. As a teacher trained in the Trinity River Watch program, you will be able to build upon the knowledge and skills already learned to help your students understand stream ecology concepts and demonstrate restoration techniques.

Interested teachers need to be willing to commit to using at least one of the Portrait of Your Stream modules (water quality, physical characteristics or biotic characteristics) during the 1999 fall semester. This commitment would require approximately six to eight class periods per module to complete. In return, we will train each teacher in the techniques needed for the curriculum.

If you would be interested in being involved in this, please give me a call or here at BRIT: (817) 332-4441 or at home (940) 382-4095. I have a few teachers I am planning to meet with interested teachers within the next few weeks to discuss the details.

I hope to hear from you soon and have a great end of the year!

Sincerely,

Brenda Swirczynski

APPENDIX B

STUDENT ASSESSMENTS

NOTE: Assessments have been modified in format and presentation.
POYS Skills Assessment

1. Label the following as either: A. could cause water pollution
   B. does not cause water pollution
   C. not sure

   ___ fertilizer
   ___ warm water
   ___ dog waste
   ___ dirt

2. You have a fish in an aquarium and you think it may be sick. What are some things you could measure to decide if your fish is sick or not?

3. You want to measure how fast water is flowing in a stream and you have the following materials:
   1 tennis ball (it floats), 1 meter stick, a watch
   Explain how you could measure the speed of the water using these items.

4. You have measured the speed of the water three times and get the following numbers:
   10
   8.5
   9
   What is the average speed of the water?

5. Go to the area with the plant. Make as many observations of the plants as you can and list them here.

6. Explain how each of these insects is different: (picture of three similar insects provided)

7. Trees that live around a stream drop their leaves in the fall. Many of these leaves end up in the water. Is this good or bad for the stream? Explain your answer.

8. Describe an insect=s life cycle.

9. List any other information you know about streams here:

POYS Knowledge Assessment

1. A sunfish is a freshwater fish. What does it eat?
   A. bugs   B. turtle eggs   C. leaves   D. I don't know

2. The following picture is a bird's eye view of a stream. Mark the best explanation for its "S" shape: (graphic of stream is provided)
   A. it is caused by soft and hard rocks in the streambed   B. animals dig out the side of the stream for homes C. the water running through it makes the shape D. all of the above

3. On a pH scale, which of the following would be considered to be neutral:
   A. lemon juice   B. cabbage juice   C. soft drink   D. shampoo

4. The following pictures are part of a topographic map. Choose the one that correctly shows the way water will flow: (topographic map graphics provided)

5. How to animals that live underwater breathe?
   A. they come up to the water's surface   B. they use gills
   C. they take air underwater with them   D. all of the above

6. What does the following graph show? (graph of gill beats per minute vs. water temperature provided)
   A. the higher the temperature, the harder it is to get oxygen
   B. the lower the temperature, the slower the gill beat
   C. all of the above   D. none of the above

7. There are insects that live part of their lives underwater.
   A. True   B. False   C. I don't know

8. The following picture is part of topographical map. Use the picture to choose the correct statement: (topographic map graphic provided)
   A. The lines that are closer together represent a lake
   B. the lines that are further apart represent a steep slope
   C. the line closer together represent a steep slope
   D. I don't know

9. Which of the following is <u>not</u> a part of the water cycle:
   A. respiration   B. polar ice caps   C. fog   D. none of the above

10. You go out and catch some animals from a stream. Based on what you find, which description shows the healthiest stream environment?A. 15 different kinds of animals B. 2 different kinds of animals, but a lot of each one
C. they are both just as healthy D. I don't know

POYS Attitude Assessment

1. You can tell a stream is healthy if it:
   A. doesn't have any trash in it B. doesn't have any sticks in it
   C. has lots of things living in it D. has a few things living in it

2. I think about water pollution:
   A. never B. rarely C. sometimes D. a lot

3. I know ___ about water pollution.
   A. very little B. a few things C. some things D. a lot

4. I know ___ about stream ecosystems
   A. very little B. a few things C. some things D. a lot

5. I get upset when I see oil and other pollutants on the road.
   A. never B. rarely C. sometimes D. a lot

6. It makes me feel ___ to know people help to keep our water supply safe to use.
   A. nothing B. okay C. glad D. great

7. In the last year, I have helped ___ to keep our water safe to use.
   A. 0 times B. 1-2 times C. 3-4 times D. 5 or more times

8. I would be willing to help improve our water quality.
   A. never B. rarely C. sometimes D. a lot

9. Water quality is important to me.
   A. strongly disagree B. disagree C. agree D. strongly agree

10. Streams are interesting to study.
    A. strongly disagree B. disagree C. agree D. strongly agree

REFERENCES

American Forestry Foundation. 1997. PLT and urban environmental education. [On-line]. Available: www.plt.org/html/branch/spring98.urban

Audubon Society. 1999. Tbilisi declaration. [On-line]. Available: www.audubon.org/chapter/ca/santamonicabay

Crocker, Betty. 1992. Changing emphases to promote inquiry. University of North Texas. EDEE class handout.

Davis, George R. 2000. Standards-based education and it=s impact on environmental science education. Journal of Science Education, 4(3).

Disinger, John F., & Roth, Charles E. 1992. Environmental literacy. ERIC/CSMEE Digest.

Firehock, K., & Doherty, J. 1995. A citizen=s streambank restoration handbook (SOS). Izaak Walton League of America, Inc. Gaithersburg, MD.

Haurey, David L., & Milbourne, Linda A. 1998. Choosing instructional materials for environmental education. ERIC/CSMEE Digest.

[LHS] Lawrence Hall of Science. 1997. River cutters teacher=s guide. University of California at Berkeley. Berkeley, CA.

Lieberman, G., & Hoody, L. 1998. Closing the gap using the environment as an integrating context for learning. Science Wizards, Poway, CA.

Lieberman, G. 1995. Pieces of a puzzle: An overview of the status of environmental education in the United States. Science Wizards, Poway, CA.

Mappin, M. 1998. Choosing an environmental monitoring program. Green Teacher, 55, 12-15.

Martin, R., Sexton, C., Wagner, K., & Gerlovich, J. 1997. Teaching science for all children (2nd ed.). Allyn and Bacon, Massachusetts.

McClaren, M. 1998. Beyond substituted experience. Green Teacher, 55, 6-10.

National Academy of Sciences. 1999. National science education standards. [On-line]. Available: www.map.edu/readingroom/books/nses/html/1

[NEETF] National Environmental Education & Training Foundation and Roper Starch Worldwide. 1998. The national report card on environmental knowledge, attitudes and behaviors: The seventh annual survey of adult Americans. NEETF, Washington, D.C.

Parry, J. 1999. A case for co-planning in EE: AWhat do you need from us?≅ Is a fine question, but it=s really a very complex one. Environmental Educator, 29,(21).

Schierloh, J. Undated. New Jersey School of Conservation, Montclair State University. Outdoor School Sites in New Jersey, 1-4.

Sladek, M. National Science Foundation. 1998. A report on the evaluation of the National Science Foundation=s informal science education program. [On-line]. Available: www.nsf.gov/pubs/1998/nsf9865

[TNRCC] Texas Natural Resources Conservation Commission. 1990. WET instruction handbook. TNRCC. Austin, TX.

(UNESCO/UNEP) United Nations. 1978. AThe Tbilisi Declaration.≅ Connect 1, no. 1.

U.S. Census Bureau. 1999. Population Projections. [On-line]. Available: www.census.gov/population/www/projections/popproj

Western Association of Fish and Wildlife Agencies and Western Regional Environmental Education Council, Inc. 1992. Project aquatic WILD aquatic education activity guide. USA.